Digitized by the Internet Archive
in 2010 with funding from
Montana State Library

http://www.archive.org/details/fisherypotential1977else

F2FP
1977

NO
ARC-76/78-15

THE FISHERY POTENTIAL OF STOCKWATER RESERVOIRS ON BUREAU OF LAND MANAGEMENT LANDS IN GARFIELD AND MCCONE COUNTIES

Al Elser
Regional Fish Manager

Scott Denson
Fisheries Field Technician

STATE DOCUMENTS COLLECTI

APR 20 2004

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

Montana Department of Fish and Game
Miles City, Montana

Montana State Library
3 0864 1005 9498 8

December 1977

The fishery potential of stockwater reservoirs on Bureau of Land Management lands in Garfield and McCone Counties.

ABSTRACT

A total of 407 stockwater reservoirs were surveyed in Garfield and McCone counties in 1976 and 1977, with 48 being suitable for fish. Most reservoirs were small (77.4% in 76 and 82.7% in 77 less than .81 ha or 2 acres in area) and shallow (74.2% in 76 and 89.6% in 77 less than 2 M or 6.56 ft. in depth). Depth and turbidity were considered the two major limiting factors for fish in most reservoirs. Fish populations were found in eight reservoirs, three of which have less than 10 percent water on BLM lands. Management recommendations were made to the Bureau of Land Management in relation to public access and fishery potential of each reservoir.

INTRODUCTION

In the past few years southeastern Montana has experienced a population explosion, with the increased interest in the coal reserves of the surrounding area. This ever growing number of people has brought about an intensified demand for recreational activities. In Montana, fishing is the most popular outdoor recreational activity. The Montana Department of Fish and Game Strategic Plan revealed that in a state well known for it's stream fishery, 49 percent of the total fishing pressure in 1975-76 was on lakes (Montana Department of Fish and Game, 1977). Since waterbased recreation is scarce in southeastern Montana, maximum recreational use of stockwater dams is essential in fulfilling this demand. In southeastern Montana, small reservoirs make up the majority of the fishery potential. Based on the Strategic Plan, reservoirs managed for trout can support an estimated 33,000 man-days of fishing pressure (1.7% of the statewide total) while warm water ponds can support 30,700 man-days of pressure (8.9% of statewide total). However, 1/3 of the trout ponds and 70 percent of the warm water ponds are located on public land where ingress is ensured. This represents 11,000 and 21,350 angler days of guaranteed supply, respectively. Current annual use of trout waters is estimated at 7,400 man-days and that is projected to increase to 10,400 man-days by 1990. Warm water ponds support 21,700 man-days currently, with a demand of 30,500 predicted for 1990. Using supply provided by ponds on public land, southeastern Montana could support 32,350 man-days of fishing pressure. Current total pressure estimate is 29,100 man-days with 40,900 predicted by 1990.

Since many ponds are short-lived and do not provide fishing for long periods of time, an ongoing program to provide new ponds is necessary. Poor landowner/sportsman relations cause land closures in many instances therefore reservoirs located on public lands will provide better angler use. Many anglers prefer to fish in ponds on public lands simply to avoid the hassel of obtaining permission from a landowner.

There are many reservoirs currently situated on BLM land which may be suitable for recreational fisheries, and new ponds are being developed each year. Although pond construction should be encouraged in all areas, priorities should be assigned to proposed pond sites. Ponds which are located close to the population centers should be given top consideration. By placing the emphasis on pond construction within this area, recreational potential will be recognized. Another top priority is to identify ponds and pond sites which are located on accessible public domain. This assures public access which enhances the recreational potential of the ponds.

This study will investigate each reservoir on BLM administered lands in Garfield and McCone counties by using certain features, i.e., water depth, water temperature, water quality, and access as parameters in determining suitability for a fish species. In this way BLM will be provided with an accurate inventory of their stockwater reservoirs and Montana Fish and Game will have a better idea of the fisheries potential represented by these ponds.

OBJECTIVES

To inventory stockwater reservoirs located on BLM lands and make fishery management recommendations on these waters.

To resurvey previously stocked ponds in order to evaluate and update management recommendations.

To evaluate potential reservoir sites and assist in water development planning for fishery purposes on BLM lands.

METHODS

The location of each reservoir was obtained from U.S.G.S. quad sheets and BLM recreation access guide maps. Photographs were taken of each reservoir. In addition to the photographs each reservoir was drawn in detail to assist in management decisions. Problem areas, i.e., dam erosion, seepage, spillway washes, and heavy silt deposition areas were given special attention.

Each reservoir was sequentially numbered and surveyed in the manner outlined in BLM manuals "Lake and Reservoir Surveys 6672" and "Water Analysis for Fisheries 6674". Field notes were recorded on Forms 6672-1 and 6674-3 and later transcribed to Forms 6672-2 and 6674-4. Photos were labeled with each ponds' number, location and other pertinent information. The size and shoreline lengths were estimated by measuring the water surface outline and comparing it with a pond of a known acreage. Depths were measured with a sounding line marked with .305 M (1.0 ft.) graduations. The light penetration was measured by a standard 20.3 cm (8 in.) Secchi disc.

In 1976 surface to bottom temperatures and dissolved oxygen series were made at 1M intervals with a model T-4 marine hydrographic thermometer and a Kemmerer sampler, respectively, with negligible differences. In 1977 surface temperatures were obtained by a standard field thermometer. In 1976 analysis for dissolved oxygen, turbidity, pH and specific conductance were made with a Hach Model DR-El/2 as outlined in the Hach methods manual. In 1977 analysis for dissolved oxygen, turbidity, and pH were made with a Hach Model DR Colorimeter (w/o specific conductance) as outlined in the Hach methods manual.

Fish populations were sampled by 38.1 (125 ft.) x 1.5 m (5 ft.) monofilament gill nets. The nets were experimental, with meshes ranging from 1.9 cm (3/4 in.) to 5.1 cm (2 in.). Scale samples from largemouth bass and rainbow trout were sent to Montana State University for mounting.

RESULTS

The 407 reservoirs studied are located in the rough, relatively arid ranch country of Garfield and McCone counties (Figure 1), at about the 686.3 to 1067.5 M (2250-3,500 ft) elevation levels. The surrounding country is a sagebrush vegetative type with variations in the amount of grass and tree cover. This type of country lends itself easily to erosion and silting is a common problem with the stockwater reservoirs on these areas. Of the 407 reservoirs studied in 76-77, 102 (25.1%) were dry and 298 (73.2%) has a silt problem related to the direct runoff into the reservoir.

In 1976 and 1977, 119 and 288 reservoirs were surveyed, respectively. A list of ponds surveyed in 1976 is included in Appendix A, while those surveyed in 1977 are shown in Appendix B. Physical parameters of the reservoirs for 1976 and 1977 are summarized in Tables 1 and 2, respectively. The ponds ranged in size from 0.04 to 3.3 surface hectares (0.1-7.5 acres) in 1976 and from 0.04 to 6.1 surface hectares (0.1-15 acres) in 1977. The ponds averaged about 0.6 hectares (1.4 acres) both years. Maximum depths ranged from 0.15 to 3.31 meters (0.5-10.9 ft.) in 1976 and averaged 1.53 meters (5.0 ft.). In 1977, the reservoirs ranged from 0.1 to 5.34 meters (0.33-17.5 ft.) in depth, with an average depth of 1.12 meters (3.67 ft.). Light penetration was greater in 1976 averaging 0.6 meters (range 0.001-3.05 m) as compared to an average depth of 0.31 meters (range 0.001-2.29 m) in 1977. Bottom material consisted of fine silt in all reservoirs with varying amounts of detritus.

The dissolved oxygen in 1976 ranged from 6.5 to 12.5 mg/l and averaged 8.47 mg/l (Table 3). In 1977 the dissolved oxygen ranged from 4.5 to 13 mg/l and averaged 9.16 mg/l (Table 4). Turbidity both years ranged from 15 to 500 FTU's (formazin tubidity units) and averaged 171.4 FTU's in 1976 and 235.7 FTU's in 1977. The pH ranged from 7.5 to 10.1 in 1976 and averaged 9.5. While the specific conductance ranged from 150 to 4,000 microhms/cm and averaged 700 microhms/cm. In 1977, pH ranged from 6.4 to 10.0 and averaged 8.17 with no data available for specific conductance.

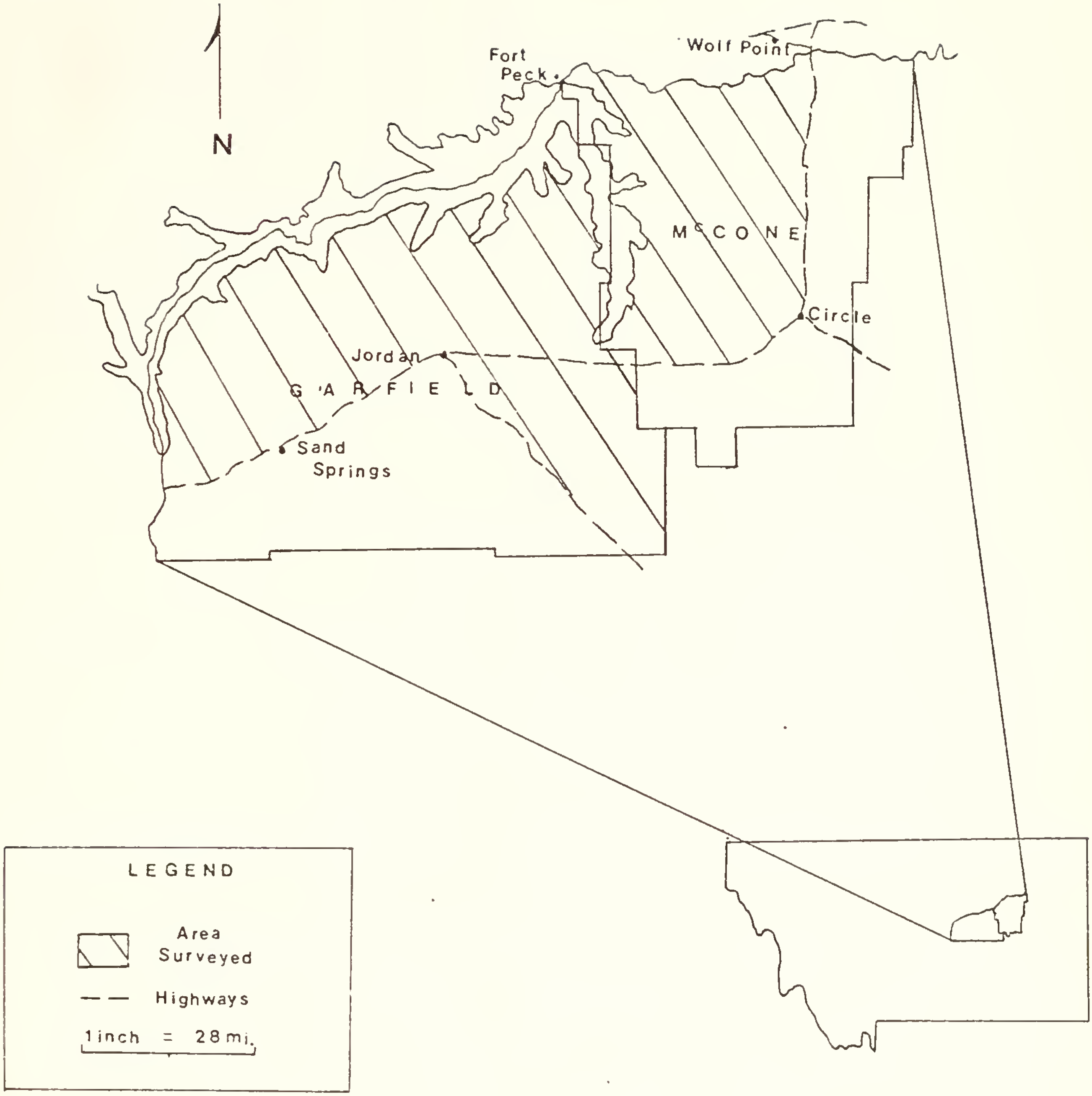

Figure 1. Map of Garfield and McCone Counties showing primary study area.

Table 1. Array of physical parameters for stock water ponds found in Garfield County, Montana, 1976.

Size (Hectares)	Number	Percent	Max. Depth (meters)	Number	Percent	Light Penetration (meters)	Number	Percent
.04 - .405	44	47.3	.1 - 1.0	29	31.2	0 - .01	40	33.6
.455 - .81	28	30.1	1.1 - 2.0	40	43.	.01 - .50	40	33.6
.85 - 1.22	13	14.0	2.1 - 3.0	15	16.1	.51 - 1.00	19	16.0
1.26 - +	8	8.6	3.1 - +	9	9.8	1.01 - 1.50	13	1.09
						1.51 - +	7	5.9
Total	93	100		93	100		93	100

Table 2. Array of physical parameters for stockwater ponds found in Garfield and McCone Counties, Montana, 1977.

Size (Hectares)	Number	Percent	Max. Depth (meters)	Number	Percent	Light Penetration (meters)	Number	Percent
.00 - .405	98	46.4	.00 - 1.0	120	56.8	0 - .010	51	24.3
.406 - .810	75	35.5	1.01 - 2.0	64	30.3	.011 - .50	109	51.9
.811 - 1.22	25	11.8	2.01 - 3.0	16	7.6	.51 - 1.00	35	16.6
1.23 - +	12	6.3	3.01 - +	11	5.3	1.01 - 1.50	12	5.7
						1.51 - +	3	1.5
	211	100		211	100		210	100

Table 3. Array of chemical parameters for stock water pond found in Garfield County, Montana, 1976.

Dissolved Oxygen mg/l	Number	Percent	pH	Number	Percent	Turbidity (FTUs)	Number	Percent	Specific Conductance (microhms/cm)	Number	Percent
6.5 - 7.5	18	32.1	7.5 - 8.0	1	1.9	0 - 50	24	40.7	0 - 250	3	7.7
7.6 - 8.5	16	28.6	8.1 - 8.5	2	3.8	51 - 100	13	22.0	251 - 500	1538.5	
8.6 - 9.5	14	25.0	8.6 - 9.0	4	7.5	101 - 150	8	13.6	501 - 750	1435.8	
9.6 - 10.5	5	8.9	9.1 - 9.5	15	28.3	151 - +	0	0	751 - 1000	1 2.6	
10.6 - +	3	5.4	9.6 - +	31	58.5		14	23.7	1001 - +	615.4	

Table 4. Array of chemical parameters for stock water pond found in Garfield and McCone Counties, Montana, 1977.

Dissolved Oxygen mg/l	Number	Percent	pH	Number	Percent	Turbidity	Number	Percent
0.0 - 7.5	34	16.9	0.0 - 8.0	64	36.6	0 - 50	32	18.4
7.6 - 8.5	67	33.3	8.1 - 8.5	70	40.0	51 - 100	34	19.5
8.6 - 9.5	30	14.9	8.6 - 9.0	31	17.7	101 - 150	16	9.2
9.6 - 10.5	25	12.4	9.1 - 9.5	8	4.6	151 - +	92	52.9
10.6 - +	45	22.5	9.6 - +	2	1.1			
Total	201	100		175	100		174	100

The majority of the ponds surveyed were small with 80.6 percent less than or equal to .81 hectare (2.0 acres) in size. Only 19.4 percent were greater than .81 hectares (2.0 acres). Ponds were found to be generally shallow, with 83.2 percent having an averaged depth less than or equal to 2.0 meters (6.56 ft.). Light penetration was not considered good, with about 79.2 percent of the ponds showing penetration no deeper than 0.50 m (1.64 ft.). This illustrates the general high incidence of turbidity in the reservoirs. This if further shown by measured turbidity (tables 3 and 4), turbidities greater than 100 FTU's were found in 55.8 percent of the ponds.

At most pond sites several orders of insects were observed among which were Odonata (dragon flies and damsel flies). Diptera, Ephemeroptera (mayflies) and Hemiptera (water boatmen). Other aquatic invertebrates observed included Gastropoda (snails) and Hirudinea (leeches).

The emergent vegetation around most ponds included cattails (*Tupha*), sweet flag (*Acorus calnmus*) and numerous types of rushes. Floating and submerged vegetation was present in most ponds and was classified as aquatic weeds.

Of the 93 ponds which contained water in 1976, 3 had existing fish populations (Table 5). These were BLM Reservoir 1 (Twitchell Reservoir) T21N, R42E, Sec. 18, BLM Reservoir 47 (Coldwell Walleye Reservoir) T21N, R40E, Sec. 10 and the BLM Reservoir 86 (Engdahl C.C. Reservoir) T20N, R36E, Sec. 13. Twitchell Reservoir had largemouth bass whereas Coldwell Walleye Reservoir had only pumkinseeds with walleyes found in a 1975 survey. The Engdahl C.C. Reservoir had a thriving population of rainbow trout ranging in size from 1.6 to 3.2 kilograms and averaging about 2.0 kilograms (4.4 lb.).

Five of the 211 reservoirs which contained water when surveyed in 1977 had existing fish populations. (Table 5). Three reservoirs with fish were situated with less than 10 percent of their surface on BLM land. These ponds were BLM reservoir 78 (T21N, R39E, S20 and 29); BLM reservoir 195 (T20N, R39E, S9) stocked with rainbow trout by the Binion Ranch. The remaining pond was BLM Reservoir 211 (T19N, R33E, S26) stocked with rainbow trout by the Saylor Ranch.

BLM reservoir 377 (Skunkbrush Reservoir, T22N, R45E, S21) contained rainbow trout, ranging in size from 0.23 to 1.36 kg (0.5-3.0 lbs.). The remaining reservoir with a fish population was BLM reservoir 385 (Taylors Bass Reservoir, T22N, R45E, S31). This reservoir had largemouth bass averaging about 2 pounds.

DISCUSSION

This study was conducted under many varied conditions and all data presented should be reviewed in a general manner. Temperature and dissolved oxygen concentrations tend to favor warm-water fish species

Table 5. Stockwater reservoirs surveyed in Garfield and McCone Counties, 1976 and 1977 which contained fish populations.

Number		T	R	S	Size (ha)	May Depth (M)	Species[1/]	Size (cm)
1	Twitchell #410	21N	42E	19	1.0	2.1	LMB	16.5-20.3
47	Coldwell	21N	40E	10	1.6	4.0	Pumkinseed	7.5
78	Binion	21N	39E	20-29	1.72	3.35	Rb	
86	Engdahl CC	20N	36E	1	.5	3.31	Rb	48.3-59.7
195	Binion	21N	39E	9	1.32	3.66	Rb	
211	Saylor	19N	33E	26	.71	1.525	Rb	20.1-44.5
377	Skunkbrush Res.	22N	45E	21	.71	5.34	Rb	20.1-52.8
385	Taylor Bass Pond	22N	45E	31	.61	3.05	LMB	40.4

[1/] LMB - Largemouth Bass; Rb - Rainbow Trout; Pumkinseed - Pumkinseed

for stocking in the reservoirs. However, in a few cases, rainbow trout are recommended. Warm-water species are generally more favorable for pond fisheries since they are more tolerant of warm temperatures and high turbidity than trout. In addition, rainbow trout are unable to spawn in reservoirs without water running into the pond.

The general criteria used to determine species to stock in a pond is as follows:

Rainbow trout: (*Salmo gairdneri*) Depth at least 3.66 M (12 ft.) over 50 percent of the pond area; low turbidity; temperatures less than 21°C (70°F); easily accessible, better than average pond.

Northern Pike: (*Esox lucius*) Depth at least 3.05 M (10 ft.) over 50 percent of the area; temperatures less than 26.6°C (80°F); area greater than 5 surface acres; good vegetation to provide reproduction potential.

Walleye Pike: (*Stizostedion vitreum*) Depth at least 3.05 M (10 ft.) over 50 percent of the area; low turbidity; temperatures less than 26.6°C (80°F); rubble and/or gravel areas to provide reproductive potential; size no consideration.

Largemouth Bass: (*Micropterus salmoides*) Depth greater than 2.135 M (7 ft.); temperatures less than 29.4°C (85°F); size, turbidity and vegetation no consideration.

Of the 48 reservoirs recommended for introductions only 6 had water qualities suitable for rainbow trout.

Eight were recommended for northern pike, 7 for walleyes and 27 for largemouth bass (Table 6-7).

Shallow depth and high turbidity were considered the major limiting factors for fish in most reservoirs. Ponds in this area are dependent on spring runoff for water supply. Water levels generally decline throughout the summer months. Therefore, the fall water level must be considered critical. Without adequate depth, reservoirs may winter kill and fish introductions would be wasted.

While turbidity itself does not kill fish, it does retard fish production and reduce the aesthetic values of the reservoir. A study conducted by Hastings and Cross (1962) in Kansas suggested that turbidity was the best single indicator of species expected in ponds. Turbidity in ponds is generally caused by fine clay particles in suspension. Land with poor vegetative cover in the drainage upstream from the pond may compliment erosion and, thereby, add large amounts of sediment during runoff. A study conducted on farm ponds showed that maximum production occurred where the average turbidity was less than 25 JTU (Jackson Turbidity Units) (Federal Water Pollution Control Administration, 1968). As turbidity increased to between 25 and 100 JTU, the ponds showed losses in fish production of 41.7 percent. In muddy ponds where turbidity

Table 6. Summary of stockwater reservoirs surveyed in Garfield County, 1976, stocked by Miles City National Fish Hatchery in 1977.

No.		T	R	S	Size (ha)	Max. Depth (M)	Road 1/ Condition	Species 2/ Planted	Size	Number
1	Twitchell #410	21N,	42E,	18	1.0	2.1	Good	NP	Fry	5,000
13	Childers #83	21N,	42E,	10	0.5	2.7	Good	LMB	2-3"	500
14	Three Bars #6595	21N,	42E,	17	0.5	2.1	Poor	WEP	Fry	3,000
15	Richie #M-2-R-1361	21N,	42E,	29	0.2	3.4	Fair	WEP	Fry	1,000
22	Upper Flat #6091	22N,	40E,	25	0.5	4.1	Excellent	LMB	2-3"	500
28	Ruby #1-C-117	22N,	41E,	25	0.5	1.5	Fair	LMB	2-3"	600
33	Breaks #2680	21N,	41E,	14	0.5	2.4	Excellent	LMB	2-3"	600
35	Lower East Flat 22	21N,	41E,	22	0.6	3.4	Excellent	WEP	Fry	3,000
41	Mid Woody Cr 26	21N,	40E,	26	1.8	2.1	Good	NP	Fry	10,000
46	Section 22 Reservoir	21N,	40E,	22	1.2	2.8	Fair	LMB	2-3"	1,000
47	Coldwell	21N,	40E,	10	1.6	4.0	Good	WEP	Fry	10,000
51	Section 31 Res.	22N,	41E,	31	0.8	2.4	Good	LMB	2-3"	500
53	Top Deck #6594	22N,	40E,	35	1.0	4.6	Fair	WEP	Fry	5,000
56	Pass Cr. #6R-1	21N,	40E,	5	0.9	2.6	Good	WEP	Fry	5,000
59	Isaacs Sec. 7	22N,	41E,	7	-	-	Poor	LMB	2-3"	600
61	Mid Flat Cr Sec. 4	21N,	40E,	4	0.8	3.1	Fair	NP	Fry	5,000
77	Hell Cr Sec. 28	21N,	37E,	28	0.5	2.1	Good	NP	Fry	5,000
85	Pearl	20N,	37E,	6	0.9	1.8	Fair	NP	Fry	6,000
86	Engdahl C.C.	20N,	36E,	1	0.6	3.3	Fair	Rb	3-4"	600
91	Last Chance	21N,	32E,	13	0.4	2.0	Poor	No Plant		
95	BLM Sec. 26	21N,	32E,	26	0.4	2.1	Poor	No Plant		
99	BLM Sec. 21	20N,	33E,	21	0.6	3.1	Good	Rb	3-4"	600
110	Childers Sec. 21	20N,	31E,	13	0.8	2.4	Poor	LMB	2-3"	500
116	McKeever Sec. 6	21N,	35E,	6	0.5	1.8	Fair	LMB	2-3"	500
117	Upper Snow Sec. 5	21N,	35E,	5	0.8	3.1	Good	Rb	3-4"	800

1/ Excellent and good road conditions - accessible with 2-wheel drive vehicle most time; Fair-Poor - accessible with 4-wheel drive or walking.

2/ NP - Northern pike; LMB - Largemouth Bass; WEP - Walleye pike; Rb - Rainbow trout.

Table 7. Summary of stockwater reservoirs surveyed in Garfield and McCone Counties, 1977, recommended for introduction of fish.

No.		T	R	S	Size (ha)	Max. Depth (M)	Road 1/ Condition	Species 2/ Recommended
153	Fork Res. #402	20N	42E,	31 NWSE	1.00	2.75	Fair	LMB
165	Bridge Coulee Res. 405	20N,	42E	2 NESE	.71	3.05	Fair	LMB
171	BLM Res. Sec. 8	20N,	41E,	8 NWNE	1.62	3.05	Fair	LMB
172	Button Butte Res. 27	20N,	41E,	1 SWNE	.51	2.14	Fair	LMB
181	Breezy Basin #408	20N	42E	18 SWNW	1.22	3.66	Good	Rb
182	Coal Slack Res. #407	20N,	42E	19 SENE	.91	2.75	Fair	WEP
184	Unseen Rock Res. 400	20N,	40E,	26 NESE	.71	1.98	Fair	LMB
199	BLM Res. Sec. 2	20N,	34E,	2 NWNE	.61	3.97	Good	LMB
202	Eagle's Nest Res.	19N,	33E,	14 NESW	.91	2.75	Poor	LMB
212	BLM Res. Sec. 3	18N,	33E,	3 SWSW	1.32	2.44	Poor	LMB
223	Lyman Res. M-2-R 1204	18N,	31E,	2 SWSW	1.82	2.44	Poor	LMB
228	BLM Res. Sec. 2	18N,	30E,	2 NESW	.91	2.135	Fair	LMB
233	BLM (7W) Res. Sec. 21	18N,	31E,	21 SENW	1.01	3.36	Good	LMB
237	BLM Res. Sec. 21	19N,	31E,	21 SESE	.71	3.05	Fair	NP or LMB
245	BLM Res. Sec. 13	18N,	30E,	13 NWSW	1.01	5.34	Good	RB
253	Ezekial #2 #331	17N,	30E,	23 SESW	.51	2.44	Fair	LMB
254	Ezekial #1 #332	17N,	30E,	21 NWSE	.405	2.135	Fair	LMB
260	BLM Res. Sec. 5	17N,	31E,	5 SESE	.91	2.135	Fair	LMB
269	BLM Res. Sec. 11	16N,	32E,	11 NENW	.51	2.135	Good	LMB
297	BLM Res. Sec. 1	17N,	40E,	1 NENE	1.22	1.98	Fair	LMB
377	Skunk Brush Res. M-2-R 1765	22N,	45E,	21 NENE	.71	5.34	Good	Rb
385	BLM Res. Sec. 31	22N,	46E,	31 SENE	.61	3.05	Good	LMB
404	BLM Res. Sec. 33	25N,	46E,	33 NENE	.46	3.05	Good	LMB

1/ Excellent and good road condition - accessible with 2-wheel drive vehicles most of the time; fair - poor - accessible with 4-wheel drive and/or walking.

2/ NP - Northern Pike; LMB - Largemouth Bass; WEP - Walleye Pike; Rb - Rainbow Trout

exceeded 100 JTU, the yield was reduced to only 18.2 percent of what it was in clear ponds. Few ponds surveyed during this study had clear water and the majority exceeded 100 JTU, suggesting limited fishery potential. Turbid water conditions can often be improved by bank stabilization and/or the establishment of good land use practices (i.e., good vegetative cover, etc.) in the watershed (Ayers, et al, 19).

Improving the access to ponds with fishery potential should be given top priority. For example, of the 48 ponds suitable for fish only 13 have adequate access for sportsmen with two wheel drive vehicles. The remaining ponds have trails which are in poor condition and in need of repairs.

The years of 1976 and 1977 were considered drought years in Garfield and McCone counties with below average runoff. With this fact in mind a greater number of reservoirs may have a fishery potential for the future as in most cases reservoirs were 5-8 feet below capacity.

The aesthetic values of the reservoirs in northwest Garfield County are high. These ponds are located in rolling hill terrain and are surrounded by stands of ponderosa pine. The natural and undisturbed beauty of these ponds enhances their recreational values.

Erosion on most watersheds accelerates the silting process and results in heavy silt loads dumped into the reservoirs. Excessive livestock use of ponds is another problem, resulting in a loss of shoreline vegetation and increased turbidity. Eighty percent of reservoirs surveyed on BLM administered lands in Garfield and McCone counties showed visible signs of shoreline degradation by livestock. Changes in land use patterns and reservoir fencing programs would help reduce the turbidity common in these ponds (Summers, 1963). Problems associated with erosion of fills and spillways could be corrected with riprap.

The Garfield, and McCone area represents a valuable resource in fishery potential. The utilization of this potential would be a valuable asset to the recreational fisheries of southeastern Montana.

LITERATURE CITED

Ayers, H.D., H.R. McCrimmon, and A.H. Berst. 19 . The Construction and Management of Farm Ponds in Ontario. Ontario Dept. of Agriculture Publ. No. 515:39 pp.

Federal Water Pollution Control Administration. 1968. Water Quality Criteria. U.S. Dept. Interior; 234 pp.

Hastings, C.E. and F.B. Cross. 1962. Farm Ponds in Douglas County, Kansas. State Biol. Sur. of Kansas Publ. No. 29: 21 pp.

Montana Department of Fish and Game. 1977. Strategic Plan for Montana Department of Fish and Game. Mimeo, December, 1977.

Summers, M.W. 1963. Managing Louisiana Fish Ponds. Louisiana Wildlife and Fish. Comm: 64 pp.

APPENDIX A

Appendix A. Summary of stockwater reservoirs surveyed in Garfield County, Montana, 1976.

No.	S.C. (microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp. (C)	Water Temp. (C)	D.O. (mg/l)	pH	S.D. (M)	Turb. (FTU's)	D. Sec.	Plant
1		2.5	2.135	15.	.178	19.5	21.0	9.0	10.0	1.22		.6	NP
2		.25	1.22	.625	.056		22.0	8.0	9.5	.305		.1	
3		.1	.305	.2	.089	19.	23.0					.1	
4		.5	1.525	1.75	.1	17.5	22.0	7.0	9.1	.5		.15	
5		1.25	1.83	5.625	.0884	23.0		8.5		.1525		.25	
6						23.0						.05	
7						20.5						1.1	
8		7.5	.61	11.25	.2575	19.0	23.0	6.5		.25		1.5	
9		.2	.15	.1	.158							.1	
10						19.0						.25	
11		.25	.61	.375	.141	19.0	20.5	7.0		.305		.15	
12												2.5	
13		1.0	2.745	6	.141	19.0	20.0	7.0		1.0		.25	LMB
14		1.0	2.135	5	.141	19.5	20.5	8.0		1.0		.25	WEP
15		.5	3.355	4	.1992	23.0	20.5	8.0		1.305		.15	WEP
16												.15	
17		3.5	.45	3.5	.1885	24.5	19.5			.01		.2	
18	S.C. = 450	.2	1.22	.6	.1262	20.0	21.0	9.5		.1		.15	
19	S.C. = 675	2.5	2.135	8.75	.1338	30.0	23.5	8.0	8.8	.3	50	.5	
20		.2	.915	.02	.063	30.0	23.5	7.0				.15	
21		2.0	.915	3.0	.1995	25.0	23.5	8.0		.1	50	.25	
22	S.C. = 325	1.25	3.05	6.25	.189	23.8	20.0	7.5	10.	1.305	15	.33	LMB
23						25.0						.2	
24		.25	1.525	1.0	.2257	27.0	24.5	8.0	9.2	1.0	60	.1	
25		.25	.915	.38	.16	22.5	23.0			.15		.15	
26		4.5	.915	9.0	.23	23.5	24.0			.05	500++	3.0	
27		1.5	1.07	3.75	.17	25.0	23.0	7.0		.1		.2	
28	S.C. = 650	1.25	2.44	6.25	.19	23.0	21.0		10	.61	55	.2	LMB
29		6.5	1.53	19.5	.28	24.5	20.5		9.8	.005	500++	.33	
30		2.5	1.68	7.5	.18	21.0	19.0		10.1	.3	120	.25	
31		.25	1.07	.38	.14	22.0	21.8		10.1	.001	500++	.2	
32						22.0						.2	
33	S.C. = 550	1.25	2.44	4.38	.13	21.5	19.0	7.0	9.1	.45	50	.3	LMB
34	S.C. = 350	1.25	1.68	3.75	.13	21.0	19.5	8.5	10.0	1	35	.2	
35		1.75	3.36	10.5	.16	21.5	19.5	6.5	8.1	1.6	25	.33	WEP
36		.1	.305	.1	.18	22.0	21.5			.001		.25	

Appendix A. continued.

No.	S.C. (microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp. (C)	Water Temp. (C)	D.O. (mg/1)	pH	S.D. (M)	Turb. (FTU's)	D. Sec.	Plant
37		1.0	1.525	2.5	.11	21.5	20.0	6.5	10.0	1.0	60	.2	
38		4.0	.15	2	.35	22.0	21.0					2.5	
39		.5	1.07	1.0	.20	25.0	22.0			.305	450	.2	
40		.25	.915	.38	.14	25.5	22.0		10.	.5	350	.2	
41		4.5	2.14	15.75	.27	27.0	19.0		10	.61	65	1.0	
42		2.0	1.22	4.0	.25	27.0	23.0	6.5	10	.315	110	.25	
43		1.25	.305	1.25	.19	28.0	24.0		10	.001	500++	.33	
44		.25	1.07	.5	.14	25.0	22.5			.001		.25	
45		.15	.76	.23	.18	25.0	22.5			.01		.25	
46		3.0	2.76	13.5	.204	16.0	14.0	7.5		2.10		.6	LMB
47		4.0	3.97	16.0	.21	27.0	18.5		10	1.68	50	.3	WEP
48		.75	1.68	2.25	.13	27.0				.15	450	.2	
49		1.25	1.37	3.13	.13	24.5	20.5			.01	500++	.2	
50						24.5						.15	
51		2.0	2.44	9.0	.15	26.5	18.5	7.5		.915	50	.3	LMB
52		2.75	1.07	4.13	.21	26.0	21.0			.001	500++	.600	
53		2.5	4.58	16.25	.13	26.0	18.5	7.5	10+	1.2	40	.25	WEP
54		.25	1.22	.5	.14	25.5	20.0	6.5	10.0	.6	125	.15	
55		1.25	1.83	4.38	.1263	17.0	19.5		10	.305	125	.2	
56		2.25	2.59	10.125	.141	16.0	15.0	10.0	10.	2.5	15	.3	WEP
57						16.0						.15	
58		1.25	1.37	2.5	.177	16.0	15.0	6.5	10	.61	100	.33	
59		1.75	2.14	6.125	.107	16.0	15.0		10	1.53	60	.4	LMB
60		.25	1.22	.625	.141	15.0	12.0			.15		.1	
61		2.0	3.05	11.0	.199	20.0	14.0	7.0		1.1		.65	NP
62		1.0	.45	1.0	.141	20.0				.001		.3	
63	S.C. = 500	1.0	1.68	3.5	.141	18.5	15.0	12.5	10.0	1.2	40	.3	
64						21.0						.15	
65						21.0						.33	
66	S.C. = 400	1.0	1.83	3.5	.141	22.0	15.0	8.5		.305	105	.3	
67	S.C. = 400	1.1	1.525	2.75	.16	20.0	15.0	9.0	10.0	.305	90	.2	
68						19.0						.75	
69	S.C. = 150	.9	1.37	1.8	.104	20.5	15.0	8.5	9.15	.15	375	.3	
70												.05	
71												.1	
72		3.25	1.525	9.75	.196	24.0	15.4	9.0	10.0	.61	50	.8	
73	S.C. = 150	.25	.7625	.5	.141	24.0	15.0	9.0	10.0	.61	50	.1	

Appendix A. Continued

No.	S.C. (Microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp. (C)	Water Temp. (C)	D.O. (mg/l)	pH	S.D. (M)	Turb. (FTU's)	D. Sec.	Plant
74	S.C. = 350	.25	.915	.5	.141	22.0	15.0	9.0	10.0	.45	50	.15	
75												.25	
76		1.0	.915	2.0	.08	20.0	15.5			.1		.33	
77	S.C. = 175	1.25	2.135	5.0	.126	15.0	13.5	7.5	9.15	1.5	15	.2	NP
78		4.25	3.35	25.0	.24	16.5	15.0	8.5	10.0	1.5	15	1.25	Rb
79		1.5	1.68	5.25	.141	19.0	12.0	9.5	9.15	.1	90	.2	
80		.8	1.68	2.0	.079	18.5	12.0	11.5	10.0	1.2	45	.15	
81												.15	
82	S.C. = 625	.5	1.07	.75	.141	17.5	11.0	8.5	9.15	.1	425	.1	
83												.5	
84	S.C. = 400	.2	.762	.1	.13	15.5	11.0	8.0	10.0	.305	70	.2	
85	S.C. = 1350	2.25	1.83	7.88	.234	8.5	10.0	10.5	9.25	.61	35	.33	NP
86		1.25	3.31	8.75	.13	8.5	10.0	9.0	9.0	.61	25	.2	Rb
87		2.0	.915	3.0	.199	9.5	10.0			.01	500+	1.75	
88	S.C. = 1200	1.5	.183	3.75	.173	9.0	10.0	8.5	9.1	.305	115	.15	
89		.25	1.07	.375	.141	15.0	10.0	8.0	10.0	.01	500++	.15	
90		.25	.45	.25	.141	16.0	11.0					.1	
91	S.C. = 300	1.0	1.98	4.0	.17	23.0	13.0	9.5	9.2	1.1	30	.2	LMB
92		.5	.61	.5	.199	21.0				.001		.20	
93		1.0	1.2	1.5	.113	19.5				.01	500	.2	
94	S.C. = 325	.75	1.53	1.875	.098	12.0	10.5	8.5	10.0	1.2	40	.15	
95		1.0	2.14	3.5	.085	12.0	10.5	9.5	10.0	1.5	10	.1	LMB
96						14.0						.1	
97		.25	.76	.50	.141	14.0					500+	.1	
98		.75	.91	1.0	.0814	14.0	10.0	9.5		.61		.15	
99	S.C. = 375	1.5	3.05	8.25	.12	10.0	8.0	9.5	9.2	3.05	10	.2	Rb
100						14.0						.33	
101						14.0						.33	
102						11.0						.10	
103		.25	.15	.06	.141	17.0	6.0			.15		.33	
104	S.C. = 1400	.75	1.22	1.88	.15	13.0	4.0	11.5	8.6	.61	60	.2	
105		.1	.15	.025	.18	12.0	4.5					.2	
106		1.25	.915	1.88	.19	16.0	4.5	10.0	9.6	.305	85	.15	
107						17.0						.15	
108						18.0						1.6	
109		.1	.45	.1	.09	18.0	5.0					.1	
110	S.C. = 4000	2.0	2.44	7.0	.25	13.0	5.5	10.5	9.3	2.0	30	.75	LMB

Appendix A. Continued

No.	S.C. (microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp. (C)	D.O. (mg/l)	pH	S.D. (M)	Turb. (FTU's)	D. Sec.	Plant
111		1.5	1.53	3.75	.16	13.0	4.5	9.5		.305	150	.2	
112	S.D. = 1150	1.0	1.68	2.25	.141	16.0	4.5		9.1	.61	50	.2	
113	S.D. = 1375	2.5	1.22	5.00	.178	14.0	4.0	9.0	8.2	.305	110	.6	
114						14.0						.2	
115		.2	.915	.3	.13	15.0	4.0	10.0	9.2	.61	70	.25	
116						11.0						.25	
117	S.C. = 400	2.0	3.05	11.0	.15	10.0	4.5	9.5	8.75	1.1	40	.2	LMB
118						14.0						.25	
119		.25	.15	.25	.141	14.0						.1	
Average	727.9	1.39	1.525	3.996	.158			8.47	9.59	.62	160.5	.361	
Average difference between air and water temperature						3.647							

APPENDIX B

Appendix B. Summary of stockwater reservoirs in Garfield and McCone Counties, Montana, 1977.

No.	S.C. (microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp. (C)	Water Temp. (C)	D.O. (mg/l)	pH	Turb. (FTU's)	S.D. (M)	D. Sec.	Plant
120		1.25	1.67	3.75	.25	19.0							
121													
122		.75	.915	1.73	.15	19.0							
123													
124		1.25	1.0	2.5	.25	21.0	19.0				.15		
125		3.75	1.68	11.25	.26	20.0	18.5	9.0	8.0		.61		
126		4.25	1.525	8.5	.24	22.0	21.0	8.0	8.0		.15		
127		3.00	1.83	9	.29	27.0	21.0	7.5			.305		
128		1.75	.61	1.75	.21	28.0	21.0	8.0	9.0		.15		
129						29.0							
130						29.0							
131		1.1	.46	1.1	.2	26.0	20.0						
132		1.0	1.83	3.0	.17	28.0	20.0	7.5			.305		
133						31.0							
134		1.75	.615	1.75	.21	28.0	20.0			500			
135						28.0						.2	
136		.25	.305	.25	.14	29.0	20.0						
137		1.0	1.37	3.0	.17	28.0	20.0	11.5		40	.45		
138						28.0							
139		1.0	1.07	2.0	.17	30.0	20.0	7.5			.305	.75	
140						30.0							
141		1.0	.61	1.0	.14	30.0	20.0	7.5			.15		
142						30.0							
143						30.0							
144													
145		.333	.76	.33	.12	30.0	19.5	7.0			.15		
146						26.0						.33	
147						26.0						1.0	
148		.25	.46	.25	.14	26.0	19.0	8.0					
149		1.0	1.37	2.5	.17	26.0	19.0	7.0			.15		
150		1.0	.915	1.5	.14	26.0	18.5	8.0			.15		
151		1.25	.610	1.25	.18	26.0	18.0				.03		
152		2.0	1.37	4.0	.18	26.0	18.0	8.5			.15		
153		2.5	2.75	10.0	.27	31.0	30.0	8.0			.61	2.0	LMB
154		.75	.46	.5	.16	30.0	20.0						
155						30.0						.15	
156												.15	

Appendix B. continued

No.	S.C. (microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp. (C)	Water Temp. (C)	D.O. (mg/l)	pH	Turb. (FTU's)	S.D. (M)	D. Sec.	Plant
157		2.0	.76	4.0	.22	31.0	20.0	7.5			.03		
158		1.25	.915	1.88	.23	31.0	21.0	8.0			.61		
159		1.0	1.22	2.0	.31	30.0	20.0	8.0			.61		
160		1.25	.915	1.88	.18	27.0	19.5	7.5			.03	.15	
161		2.75	.915	4.13	.26	28.0	19.5	8.5			.61	4.5	
162		1.25	1.22	2.5	.13	27.0	19.5	8.0			.915		
163		1.0	.915	1.5	.17	25.0	19.5	7.5			.305		
164						25.0						.5	
165		1.75	3.05	8.75	.19	25.0	18.5	9.0	8.1	120	.915		LMB
166						24.0							
167		.35	1.07	.7	.12	27.0	23.0	8.0			.61		
168		1.75	.915	2.63	.23	27.0	21.0	7.5			.15		
169		1.0	.915	1.5	.14	24.0	17.5	9.0	8.7	275	.15		
170		2.0	1.22	4.0	.28	27.0	17.0	7.0	8.1	75	.61		
171		4.0	3.05	24.0	.32	25.0	19.5	9.0	8.1	40	.915		LMB
172		1.25	2.14	3.75	.19	25.0	18.0	8.0	9.1	50	1.07		LMB
173		.75	.61	.75		24.0	17.5	7.0	7.6	425	.03		
174		4.0	1.83	9.0	.28	24.0	17.5	7.5	7.7	90	.305		
175		1.25	1.22	2.5	.18	26.0	19.0	8.0	7.5	60	1.0		
176		.75	.915	1.07		26.0	19.0	8.0	7.7	170	.305		
177		.5	.75	.915	.20	27.0	19.5	8.0	8.3	30	.305		
178						28.0							
179		.1	.305	.1	.09	28.0	20.0	7.0		500	.03	.15	
180		1.25	1.22	2.5		27.0	19.5	8.5		135	.305		
181		3.0	3.66	12.0	.29	27.0	19.0	9.0	8.5	.35	1.0		RB
182		2.25	2.75	9.0	.23	26.0	19.5	8.5	6.8	170	.305		WEP
183		1.75	1.22	3.5	.21	27.0	20.0	9.0	8.0	45	1.00		
184		1.75	1.98	4.25	.21	27.0	20.0	9.5	9.9	25	1.1	.2	LMB
185		.3	.46	.3	.13	26.0	20.0	9.0	7.9	200	.1	.5	
186												.33	
187		.25	.915	.38	.14	26.0	20.0	6.0	7.6	125	.305		
188						30.0							
189													
190						27.0							
191		.25	1.07	.3	.14	29.0	20.0	8.0	9.1	145	.1		
192		.5	1.07	1.0	.12	28.0	20.0	9.0	9.9	110	.305	.25	
193						29.0							

Appendix B. continued

No.	(Microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
194						29.0							
195		3.25	3.66	21.13	.23	29.0	19.0	9.0	8.75	35	2.0	2.5	RB
196						30.0							
197		2.0	1.22	4.0	.14	30.0	20.0	8.0	8.1	500	.01		
198		1.0	1.07	1.5		31.0	20.0	8.5	7.9				
199		1.5	3.97	9.00	.18	26.0	18.0	10.0	8.0	30	1.0	.33	LMB
200						21.0						.15	
201		1.25	1.68	3.125	.18	16.5	17.5	8.0	8.65	25	1.37	.2	
202		2.25	2.75	9.0	.28	17.5	17.5	8.0	8.7		1.0	.75	LMB
203		.3	.915	.6	.16	17.5	17.5	7.0	8.1	500++	.01	.33	
204		.25	1.22	.5	.14	17.5	17.5	7.5	6.4	35	1.0	.33	
205						19.0							
206		1.75	2.135	5.25	.21	19.0	18.0	7.5	8.6	125	.1		
207		.3	1.07	.45	.16	17.0	17.5	8.5	8.1	45	1.07	.3	
208		1.0	.15	.5	.14	17.0	17.0	8.5	8.6	55	.15		
209		.5	.915	.75	.13	15.0	16.5	7.5	7.6	35	.915	.33	
210		.3	.305	.15	.13	19.0	15.5	9.0	8.3	500	.01	.25	
211		1.75	1.525	3.5	.23	19.0	15.0	6.0	7.6	75	.76	1.0	Rb
212		3.25	2.44	14.0	.26	19.5	11.5	8.0	7.8	45	1.1	1.7	LMB
213						19.0							
214		1.0	1.525	2.5	.08	18.0	16.0	10	8.1	35	1.1	.15	
215		.75	.15	.35	.10	17.0	13.0	9.0	7.9	500++	.01	.6	
216		.75	.61	.75	.1	17.0	13.5	8.0	8.2	60	.15	.1	
217						16.5						.1	
218		1.5	.305	.75	.17	27.0	17.0	9.0	7.6	500++	.01	.25	
219		.1	.15	.025	.09	28.0	18.0			500+		.1	
220						28.0						.15	
221						28.0						.1	
222		.2	.46	.2	.06	28.0	17.5	9.0	7.7	500	.01	.15	
223		4.5	2.44	18.0	.2673	26.0	17.5	10.0	7.6	75	.5	.33	LMB
224		1.25	.915	1.875	.15	23.0	17.5	9.0	7.8	245	.1		
225						21.0	17.0				.1	.1	
226		1.25	.15	.4	.1	23.0	16.0	9.0	7.7	500	.01		
227						24.5							
228		2.25	2.135	7.875	.17	24.5	20.0	8.0	7.1	25	.915	.33	LMB
229		.75	.915	1.125	.16	27.0	20.0	8.5	7.8		.01	.25	
230		1.0	1.07	2.2	.113	26.0	17.5	8.5	7.7	500++	.01	.15	

Appendix B. continued

No.	S.C. (Microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
231		.5	.305	.25	.08	26.0	17.0	8.0	7.5	500	.01	.1	
232						27.0							
233		2.5	3.36	13.75	.196	27.5	18.5	10.0	7.8	35	1.07		LMB
234		.2	.305	.1	.063	25.0	17.5	8.0	7.8	500	.01	.1	
235						20.0							
236		2.5	1.525	6.25	.18	24.0	17.0	6.0	7.1	425	.1	1.0	
237		1.75	3.05	8.75		27.0	19.5	9.0	8.7	15	2.29	.2	NP-LMB
238		1.0	.915	1.5	.1	26.0	19.5	8.0	7.9	325	.15	.45	
239		.6	1.525	1.5	.146	27.0	19.0	8.5	8.1	40	1.0	.9	
240						26.0						.25	
241		.5	.1	.125	.06	22.0	19.5					1.25	
242		.75	.15			21.0	19.5					.33	
243													
244		1.1	.305	.5	.11	21.0	18.5				.01	.4	
245		2.5	5.34	25.0	.194	23.0	18.5	6.5	8.5	15	2.0	.6	Rb
246		1.0	1.37	2.0	.113	21.0	17.5	7.0	7.6	45	.5	.33	
247						23.0						.2	
248		.25	.458	.25	.06	21.0	17.5	8.0	8.4	75	.458	.1	
249						21.0						.05	
250						21.0						.1	
251						21.0						1.0	
252						21.0						.2	
253		1.25	2.44	5.625	.18	27.5	18.0	6.5	8.25	45	.76	.1	LMB
254		1.0	2.135	3.5	.17	26.5	19.0	9.5	8.25	30	1.71	.15	LMB
255		.5	.915	.75	.124	25.0	18.0	7.5	7.8	500	.1		
256						25.0							
257						21.0							
258		1.25	1.525	3.125	.15	21.0	17.5	8.0	8.3	425	.1		
259						20.0					.3		
260		2.25	2.135	7.875	.23	25.0	18.5	7.0	8.5	30	2.135	.7	LMB
261						26.0						.15	
262		1.25	1.4	3.125	.18	25.0	19.5	8.5	7.7	75	.5	.33	
263		.25	.61	.25	.06	25.0	19.0	7.0	8.1	500	.01	.05	
264		.3	.305	.15	.08	23.0	17.5	7.0	8.4	425	.1	.1	
265						23.0						.15	
266		1.1	.7625	1.65	.16	23.0	17.5	7.0	8.4	325	.1	.5	
267						23.0							

Appendix B. continued

No.	S.C. (microhoms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
268		2.0	1.37	4.5	.18	20.0	17.0	8.0	8.1	75	1.0	.5	
269		1.25	2.135	4.375	.15	21.0	17.5	9.5	8.1	55	.61	.33	LMB
270						26.0						.2	
271						26.0						.9	
272		.8	.305	.4	.16	25.0	17.5	7.0	8.1	500	.01	.7	
273						24.0						.25	
274		.75	.61	.75	.10	20.0	17.0	8.0	8.4	175	.1	.33	
275		1.5	1.22	3.0	.185	23.5	16.5	8.5	8.7	500++	.01	.25	
276		1.5	.305	.75	.14	25.0	17.0	7.5	7.8	500++	.01	.25	
277		3.0	1.6775	9.0	.18	25.0	16.5	11.5	8.6	65	.5		
278		1.75	.915	2.625	.14	25.0	12.5	8.0	7.4	500++	.01	.25	
279		1.75	.61	1.75	.15	25.0	13.0	8.0	7.5	500	.01	.6	
280		.75	.763	1.125	.08	25.0	13.0	7.5	8.6	65	.305	.25	
281		1.75	1.83	5.25	.17	25.0	13.0	8.5	8.7	325	.15	.33	
282		1.0	.15	.15	.28	25.0	13.0	8.0	7.6	55	.15	3.5	
283		2.25	.61	2.25	.15	25.0	13.5	8.0	7.6	500	.01	1.33	
284		1.5	.305	.75	.185	25.0	13.5	8.0	7.6	500	.01	1.4	
285		1.0	.76	1.0	.17	21.0	12.5	8.5	8.7	325	.15	.33	
286		.9	.7625	.9	.09	21.0	11.0	7.5	7.6	500	.01	.3	
287		.25	.61	.25	.06	22.0	11.5	8.0	8.4	500	.01	.1	
288						23.0						.1	
289						24.0						.3	
290						25.0						.5	
291		.5	.61	.5	.094	25.0	12.5	8.0	8.5	125	.15	.25	
292		.25	.15	.0625	.06	25.0	13.0	7.5	8.7	325	.15	.4	
293						25.0						3.0	
294		1.0	.61	1.0	.113	24.0	15.0	9.4	7.4	75	.15	.33	
295		.75	.45	.75	.16	25.0	15.0	8.5	7.8	60	.45	.2	
296		1.0	.61	1.0	.17	24.0	15.0	9.5	7.7	500	.01	.7	
297		3.0	1.98	10.5	.212	21.0	14.5	11.0	8.7	25	1.98	.7	LMB
298		2.5	1.37	5.6		20.0	14.5	10	7.3	200	.15	.6	
299		2.25	1.83	6.75	.26	10.0	12.0	8.5	7.6	55	1.5	.8	
300		2.5	.4575	2.5	.214	10.0	11.0	8.0	7.6	500	.01	1.1	
301		4.5	1.37	11.25	.28	11.0	11.5	9.0	7.7	225	.08	1.6	
302						12.0						.2	
303		.75	.4575	.75	.16	12.0	11.5	8.0	7.8	500	.01	.25	
304		.25	.305	.12	.06	12.0	11.0	8.5	7.9	250	.15	.1	

Appendix B. continued.

No.	S.C. (Microhoms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
305		1.5	.61	1.5	.14	13.0	11.0	8.5	8.2	325	.1	.33	
306		1.75	.76	2.625	.15	12.0	11.0	8.0	7.6	500	.01	.8	
307		1.25	1.22	2.5	.1515	13.0	11.0	9.5	8.3	55	1.0	1.2	
308		2.0	.61	2.0	.14	12.0	11.0	8.5	8.7	335	.1	.33	
309		.9	.61	.9	.12	10.0	10.5	8.5	8.3	125	.15	.65	
310		.3	.76	.45	.13	19.0	12.5	10.5	9.1	25	.76	.5	
311		.1	.15	.025	.09	19.0	12.0	8.5	7.8	60	.15	.75	
312		.75	2.135	2.625	.163	21.0	13.0	12	9.0	125	.1	.5	
313						20.0						.1	
314						20.0						.3	
315		.5	.61	.5	.12	20.5	12.5	10.5	9.1	60	.61	1.5	
316		.75	.61			18.0	10.0	12.	9.1	55	.61	.33	
317		.25	.45	.25	.084	19.0	11.0	12.	7.4	65		.2	
318		.25	1.37	.625	.056	15.0	3.0	11.5	8.7	45	1.0	.45	
319		1.0	2.135	3.5	.113	20.0	10.0	8.0	8.4	35	1.1	.75	
320		.25	.1	.012	.056	21.0	6.0					.6	
321		.75	.7625	1.125	.098	21.0	10.0	10.1	9.1	225	.1	.6	
322						21.0						.6	
323						24.0						.1	
324						25.0						.6	
325						25.0						.25	
326						24.0						.33	
327		1.0	1.37	2.5	.113	24.0	10.0	12.5	8.9	35	1.37	2.2	
328		.75	.305	.23	.098	24.0	10.0			500		1.0	
329		1.0	.305	.5	.085	23.0	10.0			500		.75	
330						20.0						.2	
331		1.25	.305	.75	.126	17.0	9.0	9.5	7.9	500	.01	.4	
332		.9	.915	1.35	.089	15.0	8.0	9.5	8.1	400	.1	.15	
333		.25	.15	.12	.056	15.0	5.0	10.0	7.9	60	.15	.25	
334		2.0	2.135	7.0	.18	16.0	8.0	10.5	8.1	125	.1	.25	
335		1.75	1.37	3.93	.128	20.0	9.0	9.5	8.1	500	.01	.25	
336		2.0	1.525	4.5	.18	20.0	9.0	11.5	8.3	500	.01	.25	
337						23.0						.33	
338		1.5	1.22	3.0	.16	16.0	9.0	11.0	8.3	100	.1	.6	
339		1.25	.915	1.875	.126	13.0	8.0	11.5	8.2	325	.1	.1	
340		1.5	.45	1.125	.12	13.0	8.0	10.5	7.9	500	.01	.4	
341						12.0						.33	

Appendix B. continued.

No.	S.C. (Microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
342		1.0	.305	.5	.113	10.0	8.0	11.5	8.3	500	.01	.15	
343		1.5	1.68	4.125	.138	11.0	7.0	11.5	8.3	175	.1	.3	
344		.75	.915	1.125	.13	16.0	9.0	11.0	9.0	55	.915	.2	
345		1.75	1.83	5.25	.128	19.0	9.0	11.0	9.0	225	.1	.25	
346		.75	1.07	1.31	.098	19.0	8.0	11.0	8.3	125	.1	.25	
347						18.0						.1	
348		2.0	.15	.5	.16	17.0	8.0	11.5	8.1	325	.01	.33	
349		1.25	.915	1.25	.126	17.0	2.0	11.5	8.3	125	.61	.3	
350		1.1	.915	1.65	.16	13.0	3.0	11.0	8.1	55	.61	.25	
351		1.0	1.22	2.0	.113	17.0	6.0	4.5	8.2	70	.5	.3	
352		.6	.45	.45	.109	17.0	1.0	8.5	8.3	60	.45	.5	
353						17.0						.2	
354		3.0	2.135	10.5	.195	17.0	6.0	11.5	8.7	65	1.25	1.5	
355						17.0						1.0	
356						17.0						.33	
357		1.25	.45	1.25	.126	17.0	7.0	10.5	8.7	500	.01	.2	
358		3.5	1.22	7.0	.226	15.0	6.0	10.0	8.3	325	.05	.75	
359		2.0	1.22	4.0	.14	15.0	6.0	11.0	8.3	250	.01	.5	
360		1.25	.45	.94	.126	13.0	6.0	13.0	7.6	175	.1	.33	
361		2.5	.7625	2.5	.143	11.0	3.0	11.0	8.3	125	.5	.6	
362		.75	.915	1.125	.098	16.0	2.0	10.5	9.0	75	.5	.1	
363		1.1	.76	1.38	.107	17.0	6.0	11.0	8.1	300	.01	.2	
364		3.5	.915	5.25	.166	18.0	7.0	11.0	8.3	300	.01	.7	
365		1.75	.61	1.75	.128	21.0	7.0	10.5	8.1	300	.01	.33	
366		1.75	.45	1.75	.171	22.0	8.0	11.0	8.3	425	.01	.5	
367		.5	.46	.5	.08	22.0	7.0	11.0	8.3	300	.01	.2	
368		.5	.7625	.75	.08	23.0	7.0	11.0	9.0	250	.1	.33	
369		1.1	1.37	2.2	.135	22.0	10.0	11.0	8.1	150	.1	.25	
370		3.25	.915	4.875	.181	19.0	6.0	10.5	8.1	225	.1	.6	
371		.25	.45	.25	.056	17.0	6.0	10.5	7.9	175	.1	.25	
372		1.5	.15	.376	.16	19.0	5.0	9.5	8.3	500	.01	.15	
373		1.7	1.98	5.525	.1515	18.0	9.0	11.0	8.7	30	1.0	.6	
374		1.75	.61	1.75	.17	20.0	8.0	11.0	8.2	500	.01	.25	
375		1.0	.305	.5	.085	21.0	8.0	10.5	7.7	500	.01	.2	
376						22.0						.2	
377		1.75	5.34	15.75	.171	24.0	8.0	12.0	8.0	25	1.5	.5	Rb
378		2.25	1.22	4.5	.207	23.0	8.0	10.5	8.7	175	.1		

Appendix B. continued

No.	S.C. (Microhms/cm)	Acres	Depth (M)	Acre/ft	S. Devel.	Air Temp (C)	Water Temp (C)	D.O. (mg/l)	pH	Turb (FTU's)	S.D. (M)	D. Sec.	Plant
379		.5	.915	.75	.08	21.0	8.0	11.5	8.0	175	.15	.6	
380						19.0						.5	
381		.6	.61	.6	.073	17.0	5.0	11.0	8.4	75	.61	.15	
382		1.0	.45	.75	.113	22.0	7.0	10.5	8.1	425	.01	.15	
383		3.75	.915	5.625	.277	23.0	8.0	11.5	8.4	125	.15	.65	
384		.6	.76	.75	.073	26.0	8.0	11.0	8.1	225	.15	.33	
385		1.5	3.05	7.5	.138	16.0	7.0	12.0	7.7	35	1.3	.5	LMB
386						21.0						.33	
387		.75	.76	.9375	.13	18.0	7.0	9.5	8.1	375	.01	.15	
388						14.0						.25	
389		.1	.15	.025	.089	13.0	7.0	10.5	8.0	35	.15	.15	
390		1.1	.61	1.1	.108	12.0	7.0	11.0	8.1	325	.01	.2	
391		2.5	1.37	5.625	.178	12.0	7.0	11.5	8.3	425	.01	.25	
392		.5	.305	.25	.08	11.0	6.0	9.5	8.0	500	.01	.15	
393		2.75	1.37	4.125	.187	15.0	7.0	11.5	8.4	225	.15	.33	
394		2.0	.61	2.0	.24	21.0	7.0	10.0	8.6	500	.01	.2	
395						23.0						.3	
396						23.0						.2	
397		1.1	.45	1.0	.108	20.0	7.0	11.5	8.7	500	.01	.25	
398		1.25	.915	1.875	.126	18.0	7.0	11.0	8.7	125	.15	.25	
399		.5	.7625	.625	.08	16.0	7.0	9.5	8.6	245	.1	.15	
400		.7	1.37	1.4	.135	16.0	5.0	11.0	9.1	75	.5	.4	
401		15	1.22	30.0	.182	15.0	7.0	11.0	8.4	225	.1	3.75	
402		2.75	1.37	5.5	.187	19.0	8.0	11.0	8.1	425	.01	.33	
403		3.5	1.525	8.75	.181	13.0	6.0	10.0	7.6	325	.15		
404		1.1	3.05	5.5	.134	17.0	8.0	10.0	8.2	75	.5	.2	LMB
405		1.1	1.83	3.3	.108	17.0	7.0	11.0	8.3	75	.305	.6	
406		.75	.45	.75	.098	17.0	8.0	10.0	7.7	500	.01	2.25	
407		2.25	.915	3.375	.188	16.0	7.0	11.5	7.8	325	.1	.25	
Average		1.42	1.12	3.272	.1532			9.16	8.17	235.71	.3714	.498	

Average difference between air and water temperature 7.54